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Effective of Earthquake load on Behavior of Rectangular Shear Wall in RC Frame Building

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ABSTRACT: *Structural walls, or shear walls, are elements used to resist lateral loads, such as those generated by wind and earthquakes. Structural walls are considerably deeper than typical beams or columns. This attribute gives structural walls considerable in-plane stiffness which makes structural walls a natural choice for resisting lateral loads. In addition to considerable strength, structural walls can dissipate a great deal of energy if detailed properly. Walls are an invaluable structural element when protecting buildings from seismic events. Buildings often rely on structural walls as the main lateral force resisting system. Shear walls are required to perform in multiple ways. Shear walls can then be designed to limit building damage to the specified degree. The load-deformation response of the structural walls must be accurately predicted and related to structural damage in order to achieve these performance goals under loading events of various magnitudes. The applied load is generally transferred to the wall by a diaphragm or collector or drag member. The performance of the framed buildings depends on the structural system adopted for the structure The term structural system or structural frame in structural engineering refers to load-resisting sub-system of a structure. The structural system transfers loads through interconnected structural components or members. These structural systems need to be chosen based on its height and loads and need to be carried out, etc. The selection of appropriate structural systems for building must satisfy both strength and stiffness requirements. The structural system must be adequate to resist lateral and gravity loads that cause horizontal shear deformation and overturning deformation. The efficiency of a structural system is measured in terms of their ability to resist lateral load, which increases with the height of the frame. A building can be considered as tall when the effect of lateral loads is reflected in the design. Lateral deflections of framed buildings should be limited to prevent damage to both structural and nonstructural elements. In the present study, the structural performance of the framed building with shear wall will be analysis. In this paper, the structural performance of the RC framed building with Rectangularshear wall in will be analysis. The importance of the shear wall in resist the wind and earthquake load are study, the effect of the shear walls on the conventional frame system. The best location of shear wall are near center of mass and center of gravity .The* improvement in the structural performance of the building with frame system by using shear wall is study.

KEY WORDS: *Rectangular shear wall,Structural walls,Shear walls,frame structure,Seismic Load,frame system*

I. INTRODUCTION

EarthquakeLoad

The seismic weight of building is the sum of seismic weight of all the floors. The seismic weight of each floor is its full dead load plus appropriate amount of imposed load, the latter being that part of the imposed loads that may reasonably be expected to be attached to the structure at the time of earthquake shaking. It includes the weight of permanent and movable partitions, permanent equipment, a part of the live load, etc. While computing the seismic weight of columns and walls in any storey shall be equally distributed to the floors above and below the storey.

Earthquake forces experienced by a building result from ground motions (accelerations) which are also fluctuating or dynamic in nature, in fact they reverse direction some what chaotically. The magnitude of an earthquake force depends on the magnitude of an earthquake, distance from the earthquake source(epicenter), local ground conditions that may amplify ground shaking (or dampen it), the weight(or mass) of the structure, and the type of structural system and its ability to with stand abusive cyclic loading. In theory and practice, the lateral force that a building experiences from an earthquake increases in direct proportion with the acceleration of ground motion at the building site and the mass of the building (i.e., a doubling in ground motion acceleration or building mass will double the load).This theory rests on the simplicity and validity of Newton's law of physics: F = m x a, where 'F' represents force, 'm' represents mass or weight, and 'a' represents acceleration. For example, as a car accelerates forward, a force is imparted to the driver through the seat to push him forward with the car(this force is equivalent to the weight of the driver multiplied by the acceleration or rate of change in speed of the car). As the brake is applied, the car is decelerated and a force is imparted to the driver by the seat-belt to push him back toward the seat. Similarly, as the ground accelerates back and forth during an earthquake it imparts back-and-forth(cyclic) forces to a building through its foundation which is forced to move with the ground. One can imagine a very light structure such as fabric tent that will be undamaged in almost any earthquake but it will not survive high wind. The reason is the low mass (weight) of the tent. Therefore, residential buildings generally perform reasonably well in earthquakes but are more vulnerable in high-wind load prone areas. Regardless, the proper amount of bracing is required in both cases.

Why Are Buildings With Shear Walls Preferred In Seismic Zones?

Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation.

"We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls." Mark Fintel, a noted consulting engineer in USA Shear walls in high seismic regions requires special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient; both in terms of construction cost properly designed and detailed buildings with Shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strong earthquakes is summarized in the quote: And effectiveness in minimizing earthquake damage in structural and non- Structural elements (like glass windows and building contents).

When a building is subjected to wind or earthquake load, various types of failure must be prevented:

- slipping off the foundation (sliding)

- overturning and uplift (anchorage failure)

- shear distortion (drift or racking deflection)

- collapse (excessive racking deflection)

The first three types of failure are schematically shown in the Figure 1 Clearly, the entire system must be tied together to prevent building collapse or significant deformation.

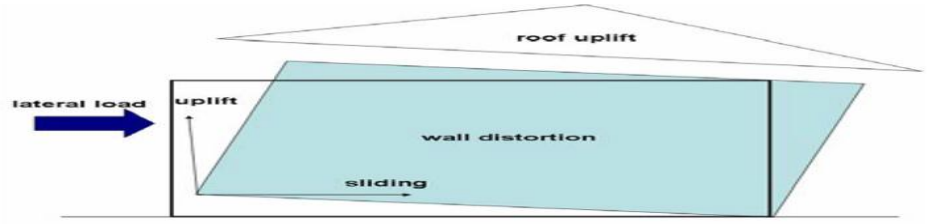
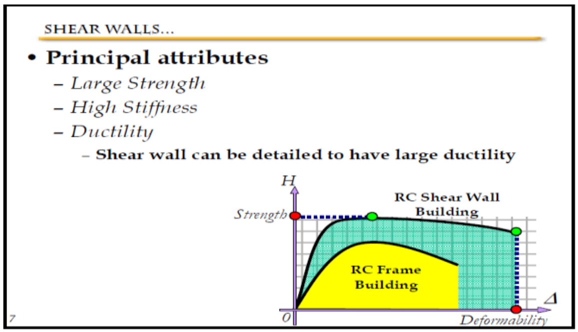
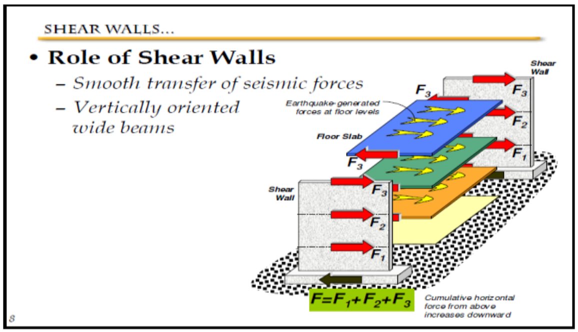


Figure 1:Schematic of the deformations of the structure due to the lateral loads

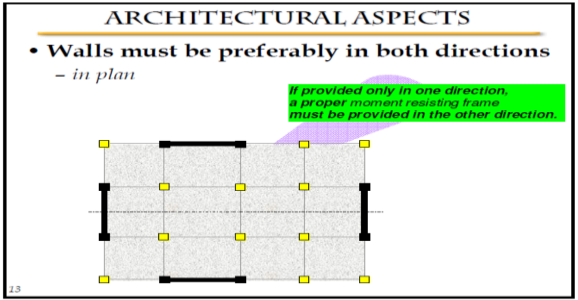
Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special Attention. Shear walls should be provided along preferably both length and width. However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane (called a moment-resistant frame) must be provided along the other direction to resist strong earthquake effects.


SHEAR WALLS…

- **Principal attributes**
  - *Large Strength*
  - *High Stiffness*
  - *Ductility*
    - **Shear wall can be detailed to have large ductility**

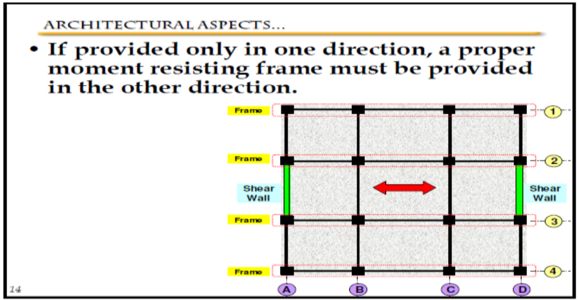

SHEAR WALLS…

- **Role of Shear Walls**
  - *Smooth transfer of seismic forces*
  - *Vertically oriented wide beams*

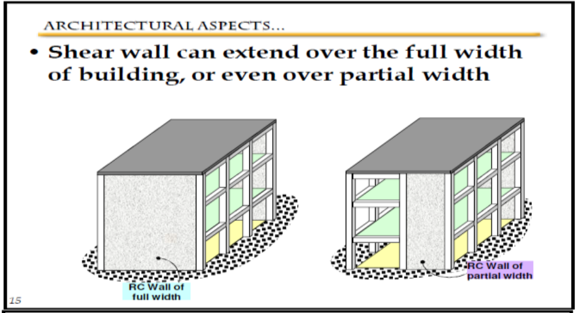

ARCHITECTURAL ASPECTS

- **Walls must be preferably in both directions**
  - *in plan*

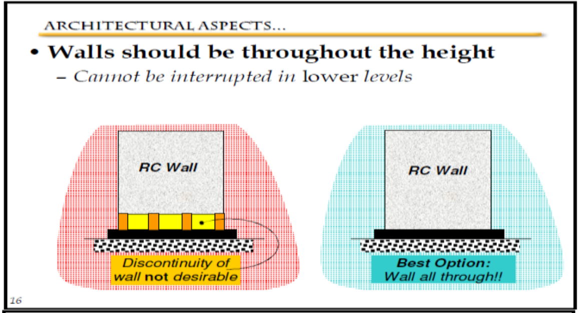
If provided only in one direction, a proper moment resisting frame must be provided in the other direction.


ARCHITECTURAL ASPECTS…

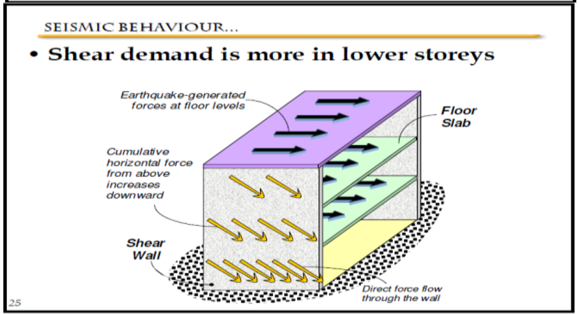
- **If provided only in one direction, a proper moment resisting frame must be provided in the other direction.**


ARCHITECTURAL ASPECTS…

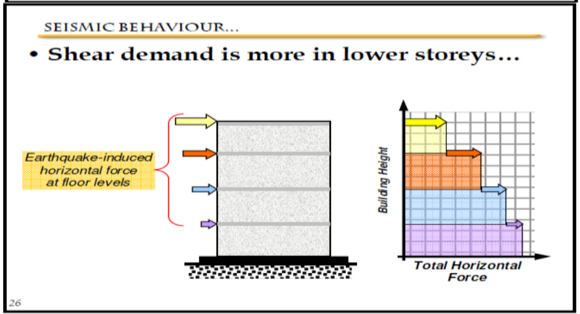
- **Shear wall can extend over the full width of building, or even over partial width**


ARCHITECTURAL ASPECTS…

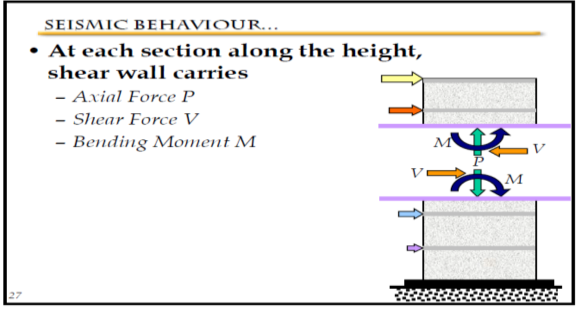
- **Walls should be throughout the height**
  - *Cannot be interrupted in lower levels*


SEISMIC BEHAVIOUR…

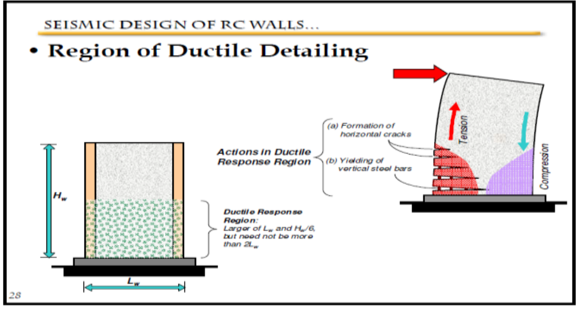
- **Shear demand is more in lower storeys**


SEISMIC BEHAVIOUR…

- **Shear demand is more in lower storeys…**


SEISMIC BEHAVIOUR…

- **At each section along the height, shear wall carries**
  - *Axial Force P*
  - *Shear Force V*
  - *Bending Moment M*


SEISMIC DESIGN OF RC WALLS…

- **Region of Ductile Detailing**

III. METHODOLOGY

When a structure vibrating. An earthquake can be resolved in any vibrating. An earthquake can be resolved in any three mutually perpendicular directions-the two horizontal directions (longitudinal and transverse displacement) and the vertical direction (rotation).This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. All the structures are designed for the combined effects of gravity loads and seismic loads to verify that adequate vertical and lateral strength and stiffness are achieved to satisfy the structural performance and acceptable deformation levels prescribed in the governing building code. Because of the inherent factor of safety used in the design specifications, most structures tend to be adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans, those in which stability for design, or for overall stability analysis of structures.

In general, most earthquake code provisions implicitly require that structures be able to resist:

1. Minor earthquakes without any damage.
2. Moderate earthquakes with negligible structural damage and some non-structural damage.
3. Major earthquakes with some structural and non-structural damage but without collapse.

The structure is expected to undergo fairly large deformations by yielding in some structural members.

To avoid collapse during a major earthquake, members must be ductile enough to absorb and dissipate energy by post-elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the event of the failure of key elements, when the element or system forces yields to fails, the lateral forces can be redistributed to a secondary system to prevent progressive primary failure.

Earthquake motion causes vibration of the structure leading to inertia forces. Thus a structure must be able to safely transmit the horizontal and the vertical inertia forces generated in the super structure through the foundation to the ground. Hence, for most of the ordinary structures, earthquake-resistant design requires ensuring that the structure has adequate lateral load carrying capacity. Seismic codes will guide a designer to safely design the structure for its intended purpose.Seismic codes are unique to a particular region or country. In India, IS 1893(Part1) : 2002is the main code that provides outline for calculating seismic design force. This force depends on the mass and seismic coefficient of the structure and the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests, and its ductility. IS 1893 (Part 1) : 2002deals with assessment of seismic loads on various structures and buildings. Whole the code centers on the calculation of base shear and its distribution over height. The analysis can be performed on the basis of the external action, the behavior of the structure or structural materials, and the type of structural model selected. Depending on the height of the structure and zone to which it belongs, type of analysis is performed. In all the methods of analyzing multi- storey buildings recommended in the code, the structure is treated as discrete system having concentrated masses at floor levels, which include half that of columns and walls above and below the floor. In addition, appropriate amount of live load at this floor is also lumped with it.

Quite a few methods are available for the earthquake analysis of buildings; two of them are presented here:

1- Equivalent Static Lateral Force Method (pseudo static method).
2- Dynamic analysis.
I. Response spectrum method.
II. Time history method.

Equivalent lateral Force (Seismic Coefficient) Method

This method of finding lateral forces is also known as the static method or the equivalent static method or the seismic coefficient method. The static method is the simplest one and it requires less computational effort and is based on formulae given in the code of practice. In all the methods of analyzing a multi storey buildings recommended in the code, the structure is treated as discrete system having concentrated masses at floor levels which include the weight of columns and walls in any storey should be equally distributed to the floors above and below the storey. In addition, the appropriate amount of imposed load at this floor is also lumped with it. It is also assumed that the structure flexible and will deflect with respect to the position of foundation the lumped mass system reduces to the solution of a system of second order differential equations. These equations are formed by distribution, of mass and stiffness in a structure, together with its damping characteristics of the ground motion.

Lateral Distribution of Base Shear

The computed base shear is now distributed along the height of the building, the shear force , at any level depends on the mass at that level and deforms shape of the structure . Earth quake forces deflect a structure into number of shapes known as the natural mode shapes. Number of natural mode shapes depends up on the degree of freedom of the system. Generally a structure has continuous system with infinite degree of freedom the magnitude of the lateral force at a particular floor (node) depends on the mass of the node , the distribution of stiffness over the height of the structure , and the nodal displacement in the given mode. The actual distribution of base share over the height of the building is obtained as the superposition of all the mode of vibration of the multi - degree of freedom system .

Dynamic Analysis

Dynamic analysis shall be performed to obtain the design seismic force, and its distribution in different levels along the height of the building, and in the various lateral load resisting element, for the following buildings:

***Regular buildings*: Those greater than 40m in height in zones IV and V, those greater than 90m in height in zone II and III.**

***Irregular buildings*: All framed buildings higher than 12m in zones IV and V, and those greater than 40m in height in zones II and III.**

The analysis of model for dynamic analysis of buildings with unusual configuration should be such that it adequately models the types of irregularities present in the building configuration. Buildings with plan irregularities, as defined in Table 4 of IS code: 1893-2002 cannot be modeled for dynamic analysis.

Dynamic analysis may be performed either by the TIME HISTORY METHOD or by the RESPONSE SPECTRUM METHOD

Time History Method

The usage of this method shall be on an appropriate ground motion and shall be performed using accepted principles of dynamics. In this method, the mathematical model of the building is subjected to accelerations from earthquake records that represent the expected earthquake at the base of the structure.

Response Spectrum Method

The word spectrum in engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. This method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site. The values of damping for building may be taken as 2 and 5 percent of the critical, for the purposes of dynamic of steel and reinforce concrete buildings, respectively. For most buildings, inelastic response can be expected to occur during a major earthquake, implying that an inelastic analysis is more proper for design. However, in spite of the availability of nonlinear inelastic programs, they are not used in typical design practice because:

1- Their proper use requires knowledge of their inner workings and theories. design criteria, and
2- Result produced are difficult to interpret and apply to traditional design criteria , and
3- The necessary computations are expensive.

Therefore, analysis in practice typically use linear elastic procedures based on the response spectrum method. The response spectrum analysis is the preferred method because it is easier to use.

IV. NUMERICAL ANALYSES

STRUCTURE

G+19 earthquake resistant structure with shear walls

Problems In The Building Due To Earthquake

Main problems that would be arising due to earthquake in the structure are story drift and deflection of the building due to its large height and also torsion and others, so if the structure is proved to be safe in all the above mentioned problems than the structure would be safe in all cases in respect earthquake.

Geometrical Properties

1.No.of stories of the Building model=20
2.Column size=500 mm x 500 mm
3.Beam size= 700 mm x 500 mm
4.Slab thickness=200mm

Loads

1.Live Load=3KN/m2
2.Wall Load=12.4KN/m
3.Floor Finishing =1KN/m2
4. Wind load
Wind coefficients
(i) Wind Speed=50m/s
(ii)Terrain Category =2
(iii) Structure Class=B
(iv) Risk Coefficient(k1)=1
(v)Topography(k3)=1
Seismic loading
(i) Seismic zone factor(Z)=0.36
(ii) Soil Type= Medium(II)
(iii) Response Reduction factor(R) =5%
(iv) Story Range=Base to 20
(v) Important factor(I)=1

Material Properties

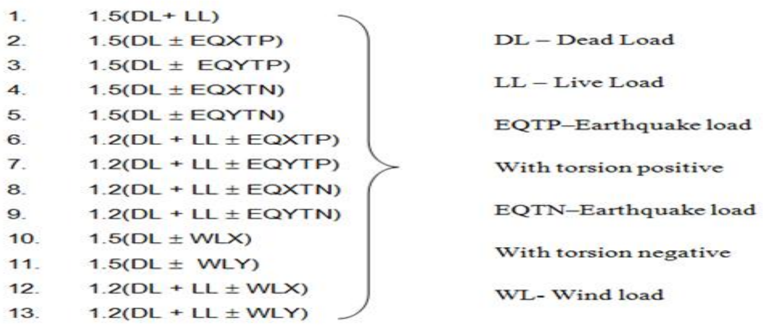
Table I : The materials used in structure and their general properties are

Material Text	Unit weight KN/m3	Elastic Modulus KN/m2	Shear Modulus KN/m2	Poisson Ratio Unit less	Thermal expansion coefficient 1/C
Concrete	23.563	24855578.28	10356490.95	0.2	0.0000099
Rebar steel	76.973	199947978.8	76903068.77	0.3	0.0000117
Bar steel	76.9730	199947978.8	769030068.77	0.3	0.0000117

Load Combinations

Load combination is the foremost important criteria for designing any structure and more important is the distribution of those loads on to various components of the structure like beams, columns, slabs and in our case shears walls and concrete core wall too. There are many kinds of loads existing depending on the location of the where the structure is to be constructed for example in a place where wind is frequent there we have to consider the wind loads and places where rains are heavy rain loads are included and same way all the other loads such as snow loads, earthquake load and etc. are included however DEAD LOADS, LIVE LOADS AND IMPOSEDLOADS are always included. Dead loads are all common depending on the structural components and specific gravity of the structure, to get the self weight of the structural component volume or area of the component is multiplied by the specific gravity of the component. Live loads depend on the purpose we are constructing the building. Imposed loads depend on the seismic loads, dead loads and according to are 1893 part 1 percentage of those values is finally considered.

The following Load Combinations have been considered for the design



1. 1.5(DL+ LL)
2. 1.5(DL ± EQXTP)
3. 1.5(DL ± EQYTP)
4. 1.5(DL ± EQXTN)
5. 1.5(DL ± EQYTN)
6. 1.2(DL + LL ± EQXTP)
7. 1.2(DL + LL ± EQYTP)
8. 1.2(DL + LL ± EQXTN)
9. 1.2(DL + LL ± EQYTN)
10. 1.5(DL ± WLX)
11. 1.5(DL ± WLY)
12. 1.2(DL + LL ± WLX)
13. 1.2(DL + LL ± WLY)

DL – Dead Load
LL – Live Load
EQTP–Earthquake load
With torsion positive
EQTN–Earthquake load
With torsion negative
WL- Wind load

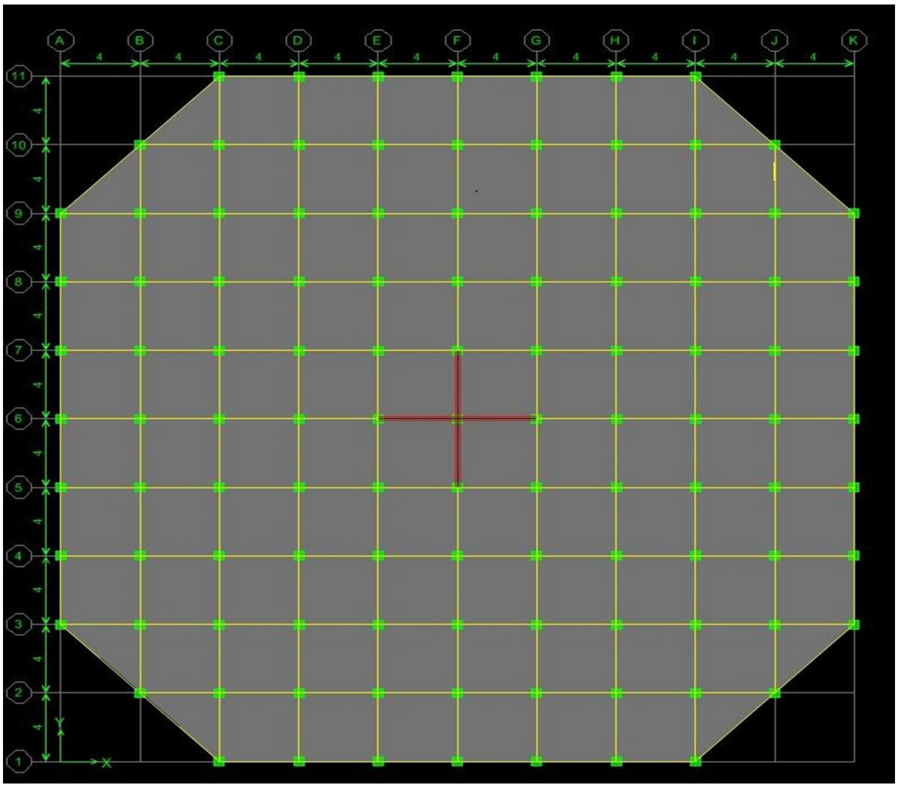
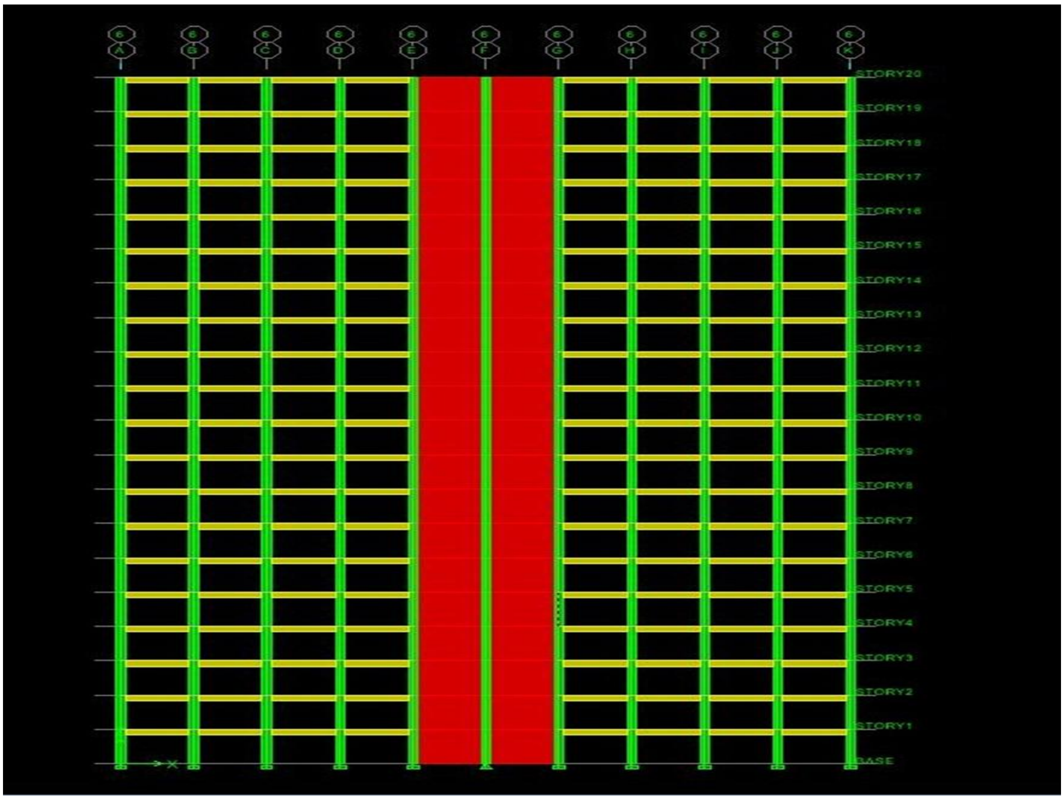


Figure 2: Basic Plan of The Building



Figur3: Elevation of the building

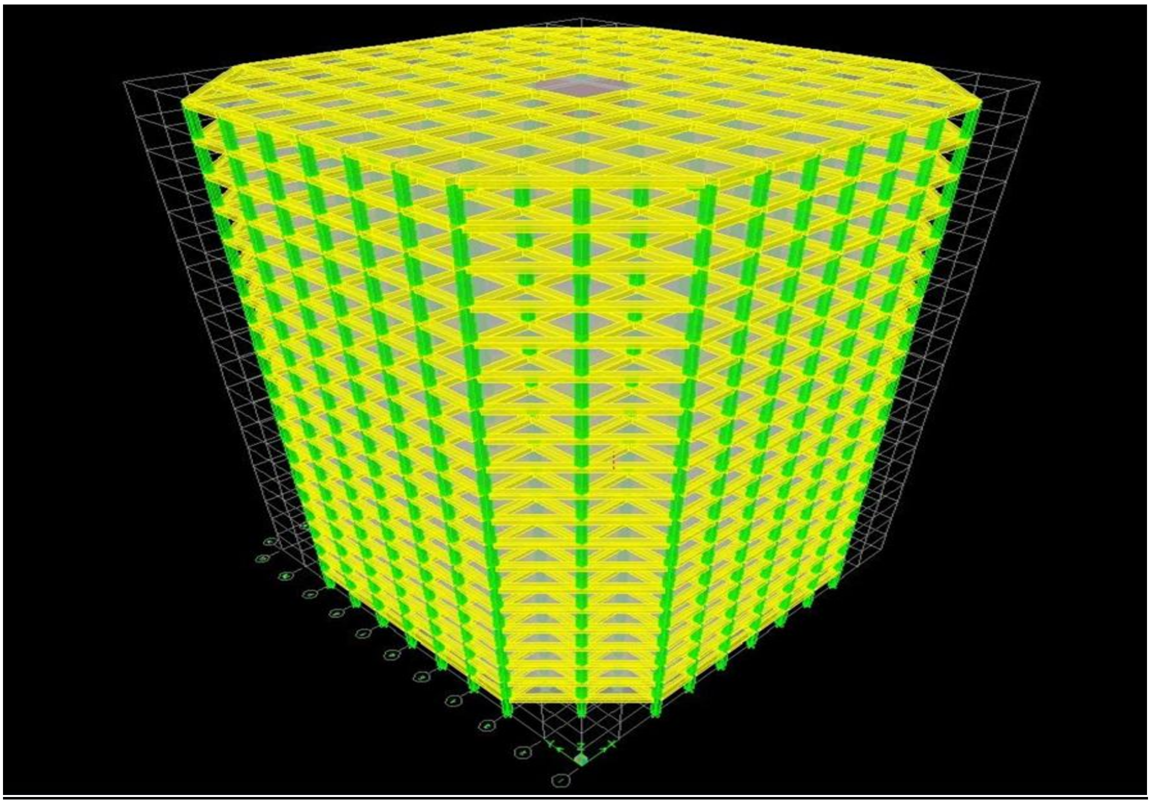
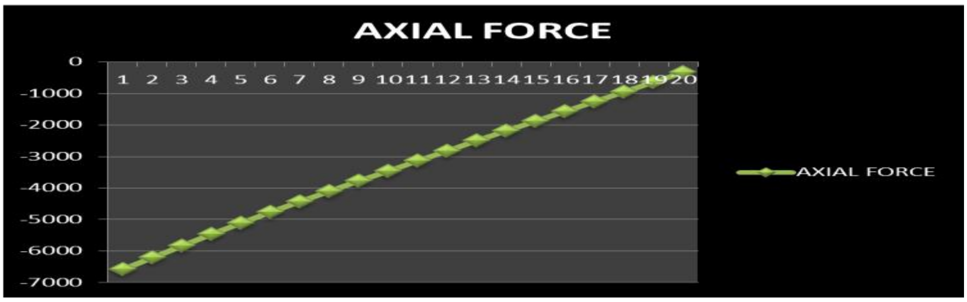


Figure 4:3-D modeling

Table II: Axial force, Shear Force, Torsion and Moment for columnC3

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C3	1.2DLLLEQX	1.25	-6586.71	52.61	-0.701	6.334
STORY2	C3	1.2DLLLEQX	1.25	-6200.93	59.27	-0.894	3.966
STORY3	C3	1.2DLLLEQX	1.25	-5829.32	64.44	-0.905	3.776
STORY4	C3	1.2DLLLEQX	1.25	-5468.27	66.37	-0.904	3.712
STORY5	C3	1.2DLLLEQX	1.25	-5116.59	65.62	-0.9	3.652
STORY6	C3	1.2DLLLEQX	1.25	-4772.84	63.28	-0.893	3.584
STORY7	C3	1.2DLLLEQX	1.25	-4435.75	59.85	-0.882	3.507
STORY8	C3	1.2DLLLEQX	1.25	-4104.19	55.63	-0.867	3.419
STORY9	C3	1.2DLLLEQX	1.25	-3777.15	50.81	-0.847	3.317
STORY10	C3	1.2DLLLEQX	1.25	-3453.8	45.45	-0.822	3.197
STORY11	C3	1.2DLLLEQX	1.25	-3133.41	39.58	-0.791	3.057
STORY12	C3	1.2DLLLEQX	1.25	-2815.39	33.18	-0.752	2.891
STORY13	C3	1.2DLLLEQX	1.25	-2499.25	26.24	-0.707	2.697
STORY14	C3	1.2DLLLEQX	1.25	-2184.64	18.75	-0.653	2.47
STORY15	C3	1.2DLLLEQX	1.25	-1871.28	10.69	-0.591	2.206
STORY16	C3	1.2DLLLEQX	1.25	-1559.02	2.14	-0.519	1.9
STORY17	C3	1.2DLLLEQX	1.25	-1247.79	-6.8	-0.438	1.549
STORY18	C3	1.2DLLLEQX	1.25	-937.67	-15.87	-0.346	1.15
STORY19	C3	1.2DLLLEQX	1.25	-628.25	-24.28	-0.243	0.701
STORY20	C3	1.2DLLLEQX	1.25	-323.52	-38.57	-0.132	0.177



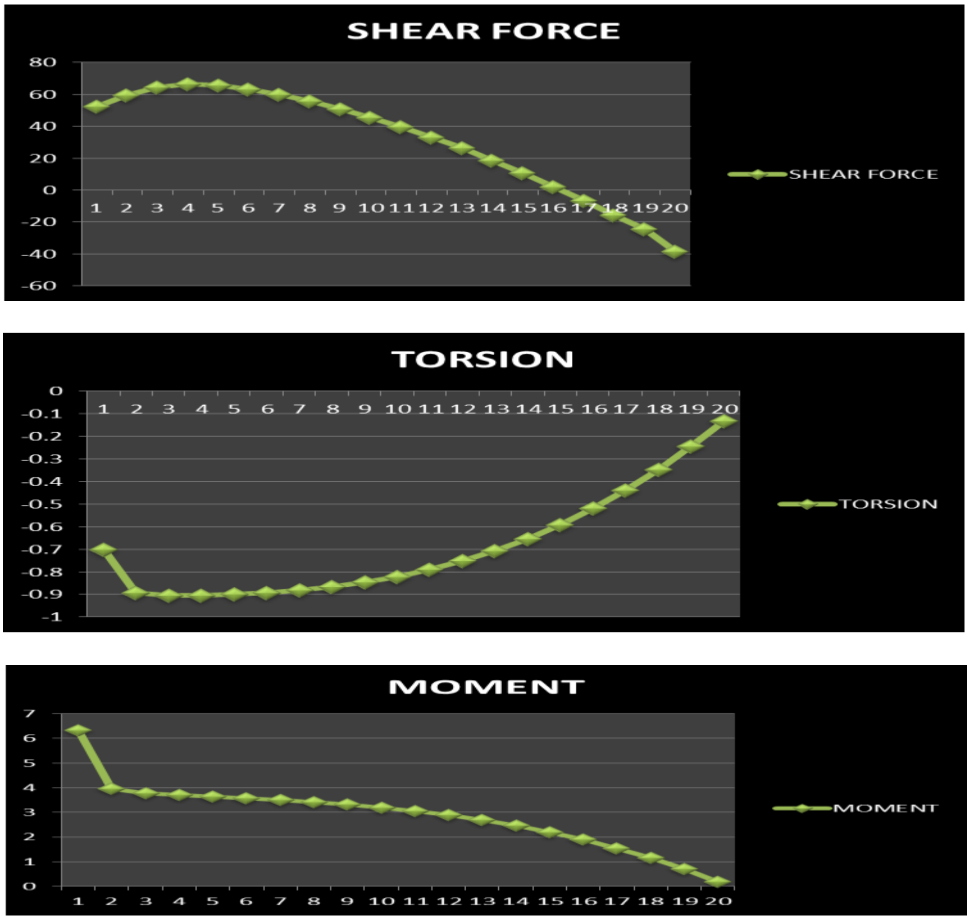
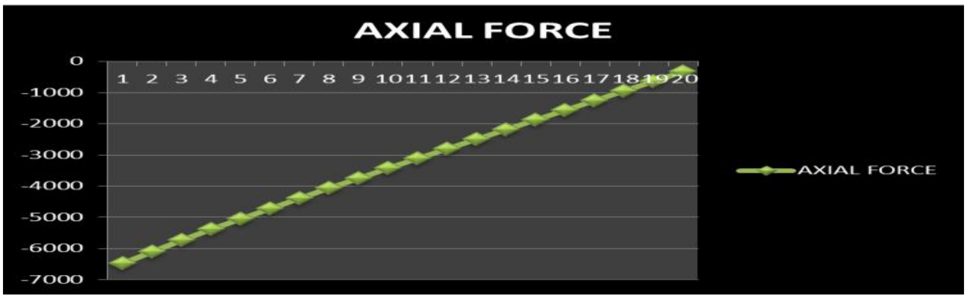


Figure 5: Axial force, Shear Force, Torsion and Moment for columnC3

Table III: Axial force, Shear Force, Torsion and Moment for columnC8

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C8	1.2DLLLEQX	1.25	-6483.38	70.63	-0.701	6.098
STORY2	C8	1.2DLLLEQX	1.25	-6102.03	76.82	-0.894	3.919
STORY3	C8	1.2DLLLEQX	1.25	-5738.56	81.5	-0.905	4.626
STORY4	C8	1.2DLLLEQX	1.25	-5386.9	83.06	-0.904	5.194
STORY5	C8	1.2DLLLEQX	1.25	-5045.42	82.04	-0.9	5.693
STORY6	C8	1.2DLLLEQX	1.25	-4712.14	79.47	-0.893	6.085
STORY7	C8	1.2DLLLEQX	1.25	-4385.38	75.81	-0.882	6.378
STORY8	C8	1.2DLLLEQX	1.25	-4063.7	71.36	-0.867	6.577
STORY9	C8	1.2DLLLEQX	1.25	-3745.86	66.25	-0.847	6.686
STORY10	C8	1.2DLLLEQX	1.25	-3430.85	60.54	-0.822	6.711
STORY11	C8	1.2DLLLEQX	1.25	-3117.82	54.24	-0.791	6.656
STORY12	C8	1.2DLLLEQX	1.25	-2806.06	47.31	-0.752	6.525
STORY13	C8	1.2DLLLEQX	1.25	-2495.05	39.72	-0.707	6.322
STORY14	C8	1.2DLLLEQX	1.25	-2184.39	31.43	-0.653	6.052
STORY15	C8	1.2DLLLEQX	1.25	-1873.8	22.44	-0.591	5.718
STORY16	C8	1.2DLLLEQX	1.25	-1563.2	12.76	-0.519	5.326
STORY17	C8	1.2DLLLEQX	1.25	-1252.59	2.5	-0.438	4.88
STORY18	C8	1.2DLLLEQX	1.25	-942.27	-8.14	-0.346	4.393
STORY19	C8	1.2DLLLEQX	1.25	-632.04	-18.38	-0.243	3.859
STORY20	C8	1.2DLLLEQX	1.25	-326.92	-34.34	-0.132	2.942



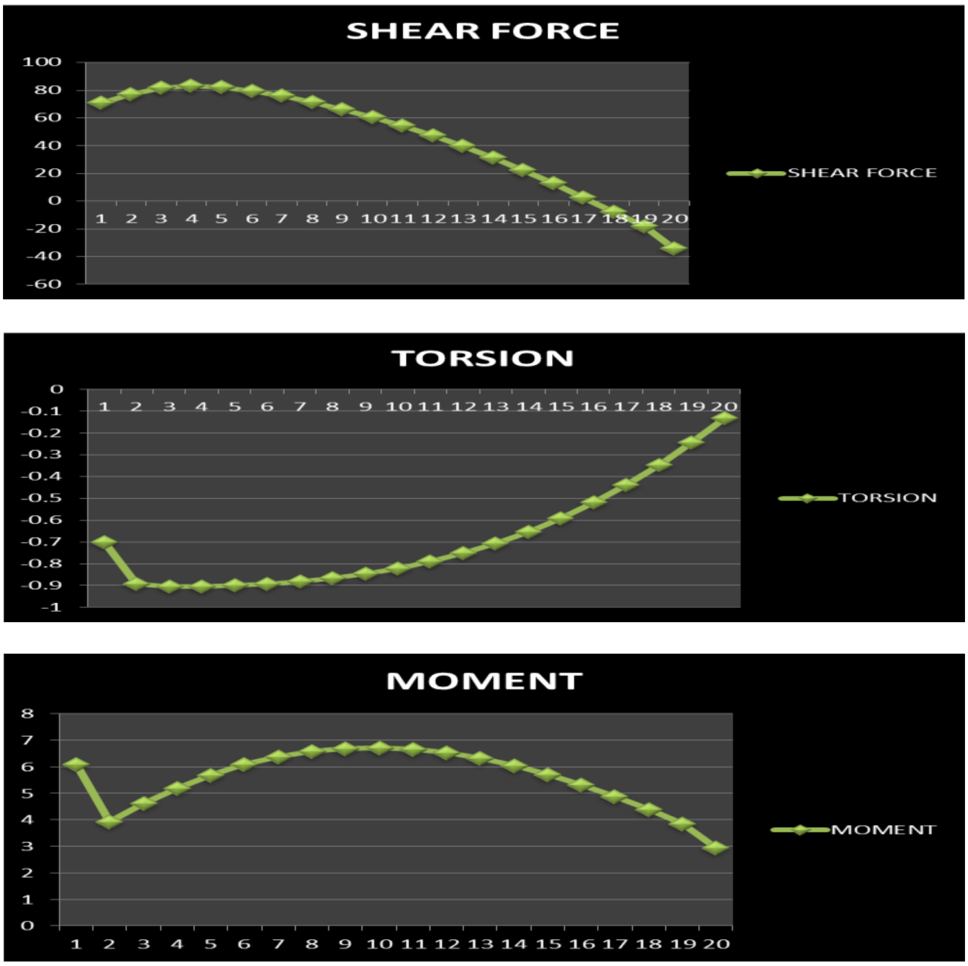


Figure 6: Axial force,Shear Force, Torsion and Moment for columnC8

Table IV: Axial force, Shear Force, Torsion and Moment for columnC11

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C11	1.2DLLLEQX	1.25	-6934.71	55.69	-0.701	4.552
STORY2	C11	1.2DLLLEQX	1.25	-6553.17	70.43	-0.894	3.132
STORY3	C11	1.2DLLLEQX	1.25	-6175.2	84.53	-0.905	3.318
STORY4	C11	1.2DLLLEQX	1.25	-5801.64	93.99	-0.904	3.609
STORY5	C11	1.2DLLLEQX	1.25	-5432.62	100.01	-0.9	3.89
STORY6	C11	1.2DLLLEQX	1.25	-5068.25	103.61	-0.893	4.153
STORY7	C11	1.2DLLLEQX	1.25	-4708.5	105.35	-0.882	4.393
STORY8	C11	1.2DLLLEQX	1.25	-4353.24	105.61	-0.867	4.606
STORY9	C11	1.2DLLLEQX	1.25	-4002.28	104.62	-0.847	4.788
STORY10	C11	1.2DLLLEQX	1.25	-3655.37	102.52	-0.822	4.935
STORY11	C11	1.2DLLLEQX	1.25	-3312.23	99.38	-0.791	5.045
STORY12	C11	1.2DLLLEQX	1.25	-2972.55	95.27	-0.752	5.114
STORY13	C11	1.2DLLLEQX	1.25	-2636.01	90.21	-0.707	5.14
STORY14	C11	1.2DLLLEQX	1.25	-2302.29	84.25	-0.653	5.12
STORY15	C11	1.2DLLLEQX	1.25	-1971.05	77.46	-0.591	5.052
STORY16	C11	1.2DLLLEQX	1.25	-1641.95	69.92	-0.519	4.934
STORY17	C11	1.2DLLLEQX	1.25	-1314.64	61.83	-0.438	4.764
STORY18	C11	1.2DLLLEQX	1.25	-988.78	53.48	-0.346	4.534
STORY19	C11	1.2DLLLEQX	1.25	-663.86	45.12	-0.243	4.324
STORY20	C11	1.2DLLLEQX	1.25	-341.55	41.25	-0.132	3.098

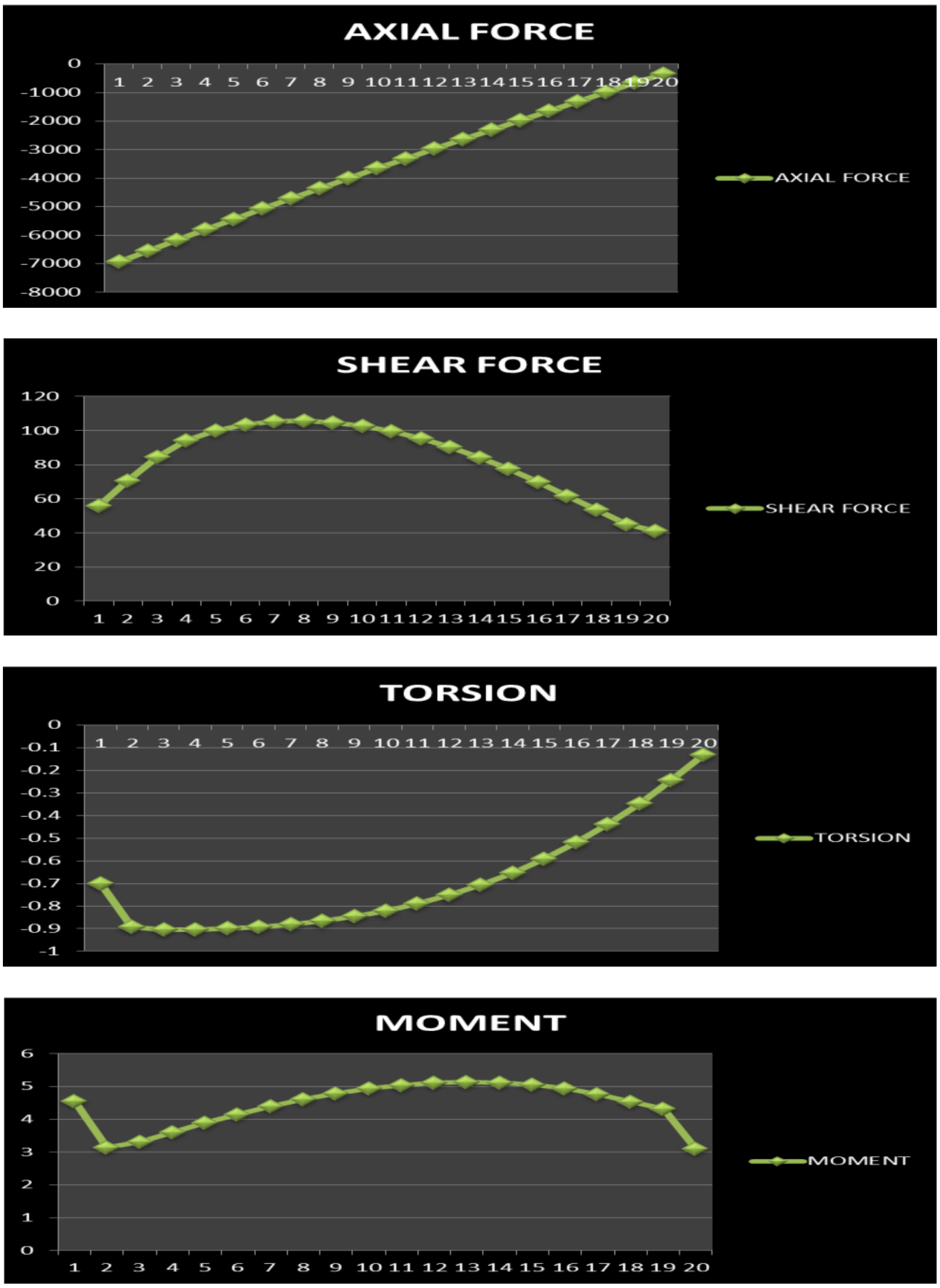


Figure 7:Axial force, Shear Force, Torsion and Moment for columnC11

Table V: Axial force, Shear Force, Torsion and Moment for columnC14

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C14	1.2DLLLEQX	1.25	-6783.79	68.36	-0.701	5.024
STORY2	C14	1.2DLLLEQX	1.25	-6402.91	86.42	-0.894	2.786
STORY3	C14	1.2DLLLEQX	1.25	-6026.73	103.62	-0.905	2.16
STORY4	C14	1.2DLLLEQX	1.25	-5656.24	116.05	-0.904	1.645
STORY5	C14	1.2DLLLEQX	1.25	-5291.65	124.87	-0.9	1.14
STORY6	C14	1.2DLLLEQX	1.25	-4932.95	131.05	-0.893	0.644
STORY7	C14	1.2DLLLEQX	1.25	-4579.98	135.11	-0.882	0.16
STORY8	C14	1.2DLLLEQX	1.25	-4232.4	137.42	-0.867	-0.311
STORY9	C14	1.2DLLLEQX	1.25	-3889.84	138.19	-0.847	-0.769
STORY10	C14	1.2DLLLEQX	1.25	-3551.85	137.55	-0.822	-1.214
STORY11	C14	1.2DLLLEQX	1.25	-3217.98	135.59	-0.791	-1.647
STORY12	C14	1.2DLLLEQX	1.25	-2887.78	132.36	-0.752	-2.069
STORY13	C14	1.2DLLLEQX	1.25	-2560.83	127.9	-0.707	-2.484
STORY14	C14	1.2DLLLEQX	1.25	-2236.72	122.26	-0.653	-2.894
STORY15	C14	1.2DLLLEQX	1.25	-1915.07	115.51	-0.591	-3.302
STORY16	C14	1.2DLLLEQX	1.25	-1595.53	107.77	-0.519	-3.712
STORY17	C14	1.2DLLLEQX	1.25	-1277.79	99.22	-0.438	-4.128
STORY18	C14	1.2DLLLEQX	1.25	-961.52	90.17	-0.346	-4.537
STORY19	C14	1.2DLLLEQX	1.25	-646.26	80.65	-0.243	-5.113
STORY20	C14	1.2DLLLEQX	1.25	-333.95	79.49	-0.132	-3.98

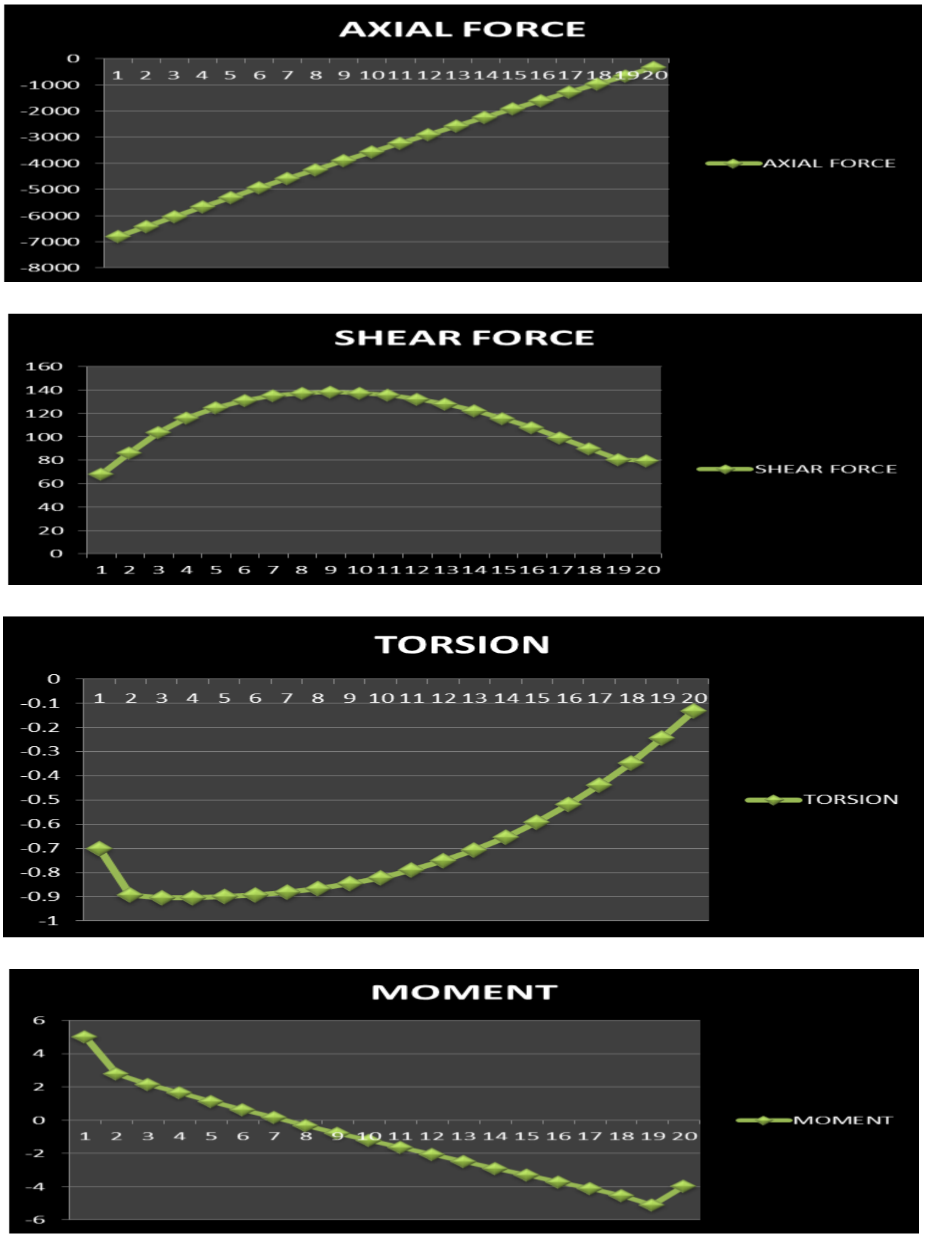


Figure 8: Axial force, Shear Force, Torsion and Moment for columnC14

Table VI: Axial force, Shear Force, Torsion and Moment for columnC3

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C3	1.2DLLLEQY	1.25	-6800.3	4.62	0.699	22.041
STORY2	C3	1.2DLLLEQY	1.25	-6418.46	-1.51	0.888	18.985
STORY3	C3	1.2DLLLEQY	1.25	-6047	-7.82	0.899	21.631
STORY4	C3	1.2DLLLEQY	1.25	-5683.41	-13.23	0.898	23.242
STORY5	C3	1.2DLLLEQY	1.25	-5326.54	-18.08	0.894	24.182
STORY6	C3	1.2DLLLEQY	1.25	-4975.29	-22.37	0.887	24.671
STORY7	C3	1.2DLLLEQY	1.25	-4628.75	-26.18	0.876	24.792
STORY8	C3	1.2DLLLEQY	1.25	-4286.17	-29.55	0.861	24.613
STORY9	C3	1.2DLLLEQY	1.25	-3946.92	-32.55	0.841	24.169
STORY10	C3	1.2DLLLEQY	1.25	-3610.48	-35.22	0.816	23.484
STORY11	C3	1.2DLLLEQY	1.25	-3276.39	-37.61	0.784	22.572
STORY12	C3	1.2DLLLEQY	1.25	-2944.31	-39.76	0.746	21.443
STORY13	C3	1.2DLLLEQY	1.25	-2613.93	-41.71	0.7	20.104
STORY14	C3	1.2DLLLEQY	1.25	-2284.99	-43.49	0.646	18.571
STORY15	C3	1.2DLLLEQY	1.25	-1957.31	-45.15	0.584	16.865
STORY16	C3	1.2DLLLEQY	1.25	-1630.72	-46.71	0.512	15.021
STORY17	C3	1.2DLLLEQY	1.25	-1305.11	-48.21	0.431	13.102
STORY18	C3	1.2DLLLEQY	1.25	-980.44	-49.65	0.339	11.198
STORY19	C3	1.2DLLLEQY	1.25	-656.24	-50.72	0.236	9.531
STORY20	C3	1.2DLLLEQY	1.25	-335.79	-59.21	0.125	6.297

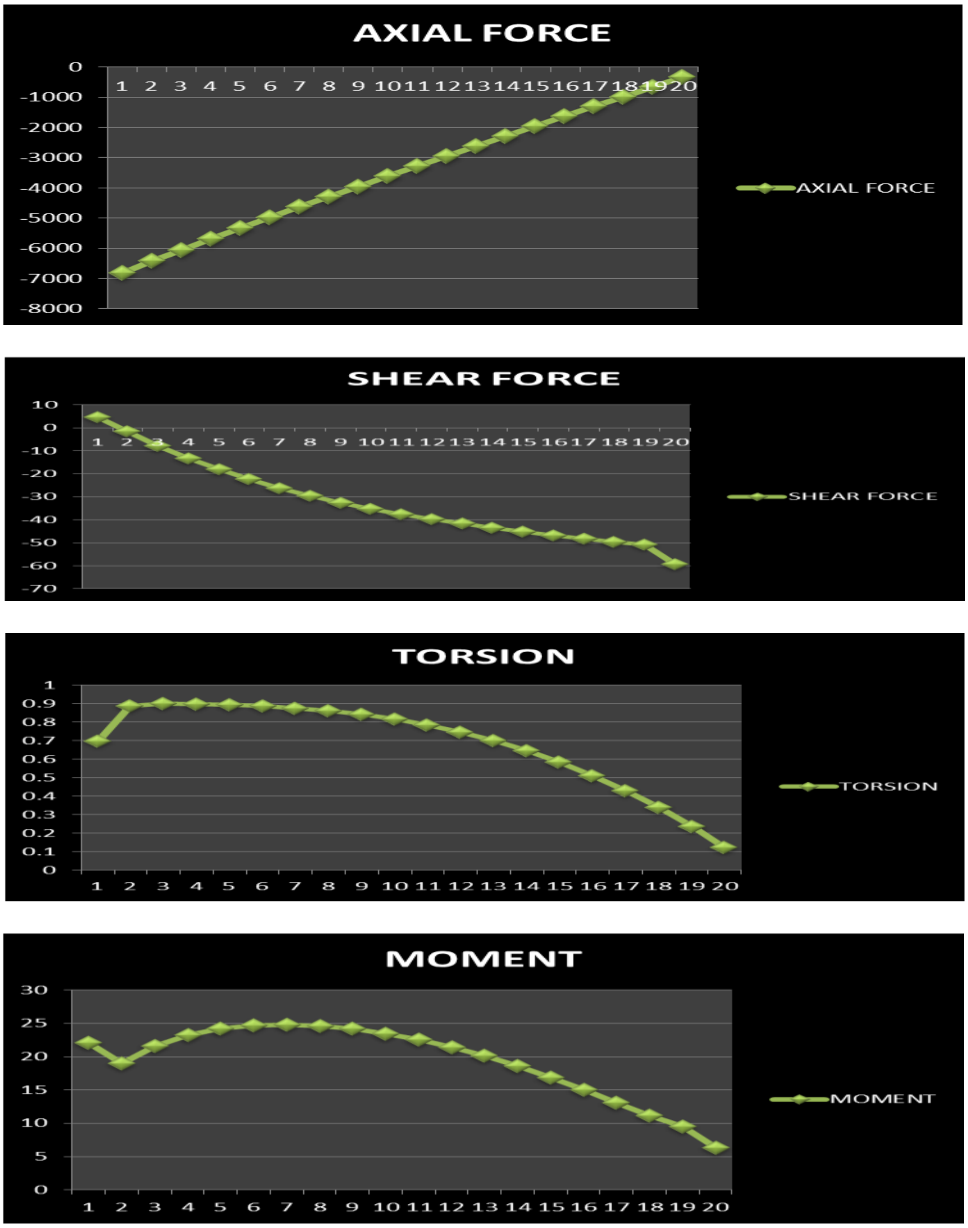


Figure 9:Axial force, Shear Force, Torsion and Moment for columnC3

TableVII:Axial force, Shear Force, Torsion and Moment for columnC8

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C8	1.2DLLLEQY	1.25	-7206.65	-12.14	0.699	22.482
STORY2	C8	1.2DLLLEQY	1.25	-6830.45	-15.16	0.888	18.521
STORY3	C8	1.2DLLLEQY	1.25	-6457.85	-18.41	0.899	20.64
STORY4	C8	1.2DLLLEQY	1.25	-6087.2	-21.12	0.898	21.731
STORY5	C8	1.2DLLLEQY	1.25	-5718.21	-23.56	0.894	22.221
STORY6	C8	1.2DLLLEQY	1.25	-5350.65	-25.72	0.887	22.322
STORY7	C8	1.2DLLLEQY	1.25	-4984.45	-27.66	0.876	22.115
STORY8	C8	1.2DLLLEQY	1.25	-4619.6	-29.38	0.861	21.665
STORY9	C8	1.2DLLLEQY	1.25	-4256.11	-30.9	0.841	21.004
STORY10	C8	1.2DLLLEQY	1.25	-3894.04	-32.25	0.816	20.152
STORY11	C8	1.2DLLLEQY	1.25	-3533.42	-33.41	0.784	19.118
STORY12	C8	1.2DLLLEQY	1.25	-3174.31	-34.4	0.746	17.909
STORY13	C8	1.2DLLLEQY	1.25	-2816.75	-35.21	0.7	16.53
STORY14	C8	1.2DLLLEQY	1.25	-2460.74	-35.84	0.646	14.991
STORY15	C8	1.2DLLLEQY	1.25	-2106.3	-36.26	0.584	13.309
STORY16	C8	1.2DLLLEQY	1.25	-1753.39	-36.47	0.512	11.516
STORY17	C8	1.2DLLLEQY	1.25	-1401.92	-36.44	0.431	9.663
STORY18	C8	1.2DLLLEQY	1.25	-1051.81	-36.13	0.339	7.851
STORY19	C8	1.2DLLLEQY	1.25	-702.51	-35.39	0.236	6.167
STORY20	C8	1.2DLLLEQY	1.25	-356.75	-38.38	0.125	3.988

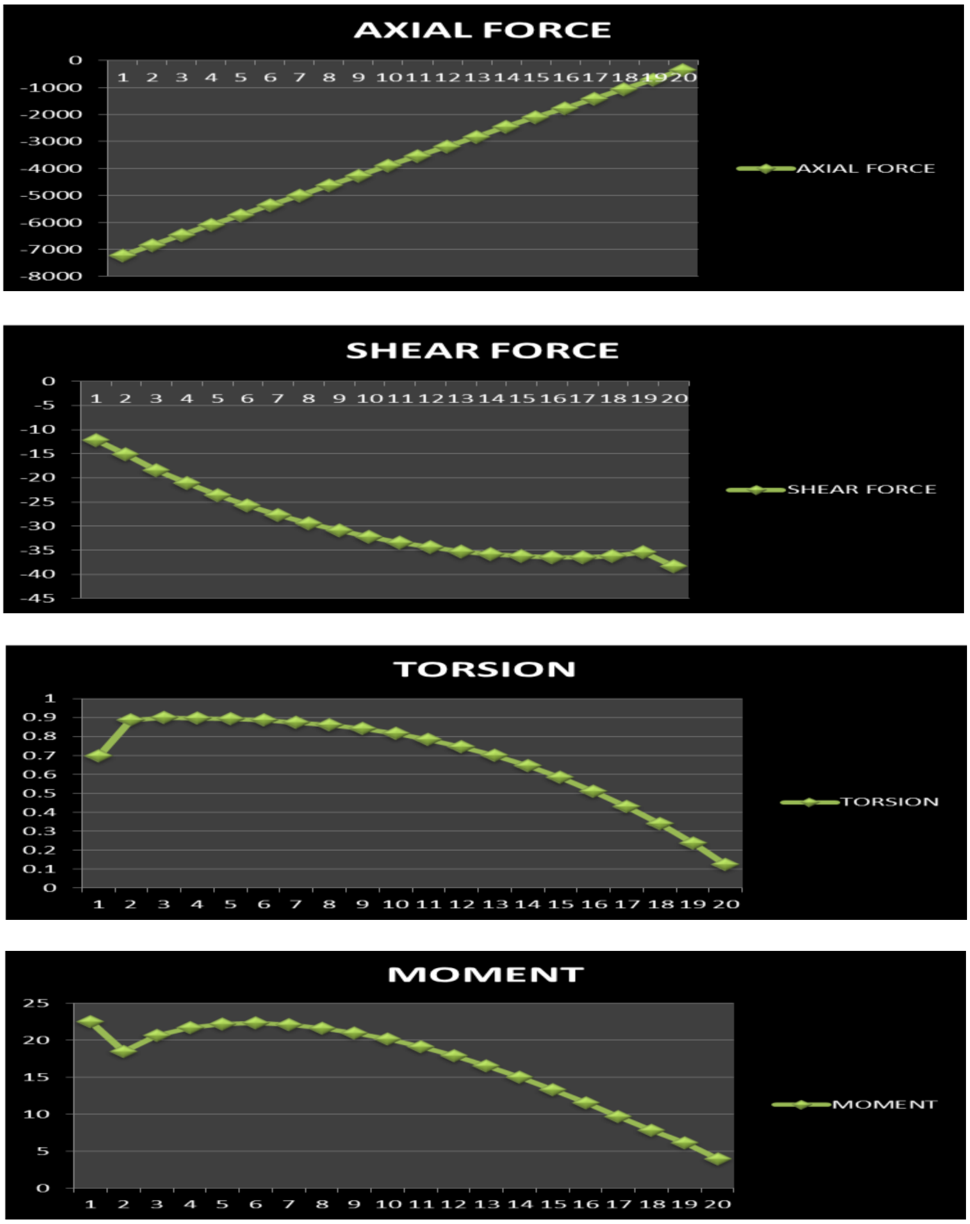


Figure 10: Axial force, Shear Force, Torsion and Moment for columnC8

TableVIII:Axial force, Shear Force, Torsion and Moment for columnC11

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C11	1.2DLLLEQY	1.25	-7019.18	7.49	0.699	23.415
STORY2	C11	1.2DLLLEQY	1.25	-6636.78	7.82	0.888	20.128
STORY3	C11	1.2DLLLEQY	1.25	-6257.96	8	0.899	23.039
STORY4	C11	1.2DLLLEQY	1.25	-5883.17	8.11	0.898	24.968
STORY5	C11	1.2DLLLEQY	1.25	-5512.48	8.2	0.894	26.213
STORY6	C11	1.2DLLLEQY	1.25	-5145.94	8.27	0.887	26.992
STORY7	C11	1.2DLLLEQY	1.25	-4783.48	8.33	0.876	27.383
STORY8	C11	1.2DLLLEQY	1.25	-4425	8.38	0.861	27.449
STORY9	C11	1.2DLLLEQY	1.25	-4070.31	8.41	0.841	27.224
STORY10	C11	1.2DLLLEQY	1.25	-3719.21	8.41	0.816	26.731
STORY11	C11	1.2DLLLEQY	1.25	-3371.44	8.36	0.784	25.981
STORY12	C11	1.2DLLLEQY	1.25	-3026.76	8.26	0.746	24.985
STORY13	C11	1.2DLLLEQY	1.25	-2684.87	8.09	0.7	23.751
STORY14	C11	1.2DLLLEQY	1.25	-2345.49	7.85	0.646	22.292
STORY15	C11	1.2DLLLEQY	1.25	-2008.31	7.51	0.584	20.632
STORY16	C11	1.2DLLLEQY	1.25	-1673.02	7.07	0.512	18.807
STORY17	C11	1.2DLLLEQY	1.25	-1339.31	6.52	0.431	16.878
STORY18	C11	1.2DLLLEQY	1.25	-1006.85	5.84	0.339	14.932
STORY19	C11	1.2DLLLEQY	1.25	-675.19	5.03	0.236	13.272
STORY20	C11	1.2DLLLEQY	1.25	-345.76	4.54	0.125	9.105

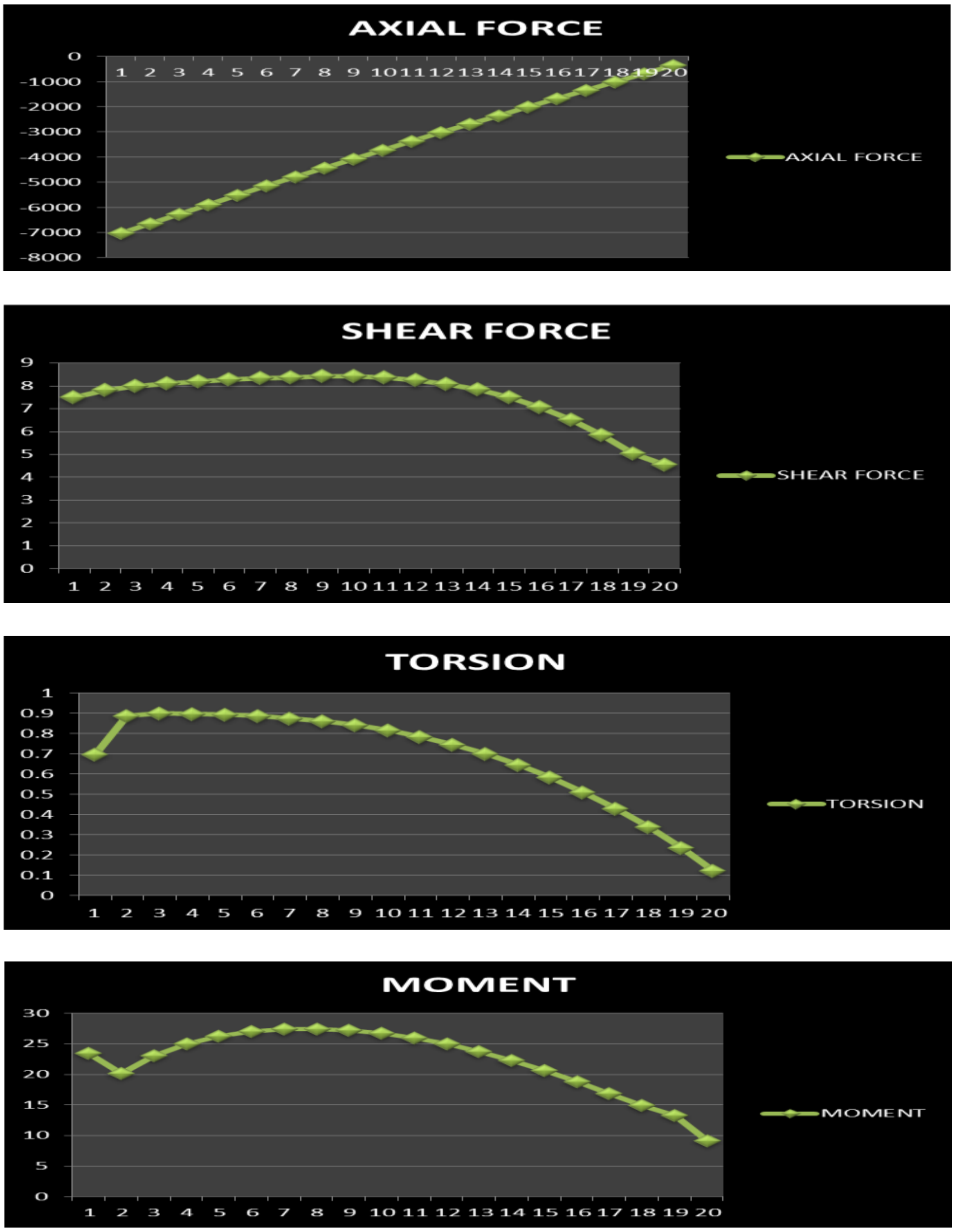


Figure 11: Axial force, Shear Force, Torsion and Moment for columnC11

Table IX:Axial force Shear Force, Torsion and Moment for columnC14

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C14	1.2DLLLEQY	1.25	-7070.16	-2.85	0.699	23.743
STORY2	C14	1.2DLLLEQY	1.25	-6687.15	-1.09	0.888	19.879
STORY3	C14	1.2DLLLEQY	1.25	-6307.79	0.76	0.899	22.248
STORY4	C14	1.2DLLLEQY	1.25	-5932.5	2.54	0.898	23.621
STORY5	C14	1.2DLLLEQY	1.25	-5561.29	4.27	0.894	24.322
STORY6	C14	1.2DLLLEQY	1.25	-5194.1	5.95	0.887	24.57
STORY7	C14	1.2DLLLEQY	1.25	-4830.76	7.59	0.876	24.446
STORY8	C14	1.2DLLLEQY	1.25	-4471.07	9.18	0.861	24.018
STORY9	C14	1.2DLLLEQY	1.25	-4114.8	10.72	0.841	23.322
STORY10	C14	1.2DLLLEQY	1.25	-3761.7	12.22	0.816	22.383
STORY11	C14	1.2DLLLEQY	1.25	-3411.5	13.65	0.784	21.215
STORY12	C14	1.2DLLLEQY	1.25	-3063.94	15.03	0.746	19.831
STORY13	C14	1.2DLLLEQY	1.25	-2718.74	16.33	0.7	18.241
STORY14	C14	1.2DLLLEQY	1.25	-2375.63	17.56	0.646	16.46
STORY15	C14	1.2DLLLEQY	1.25	-2034.36	18.71	0.584	14.513
STORY16	C14	1.2DLLLEQY	1.25	-1694.65	19.78	0.512	12.436
STORY17	C14	1.2DLLLEQY	1.25	-1356.25	20.77	0.431	10.293
STORY18	C14	1.2DLLLEQY	1.25	-1018.89	21.67	0.339	8.186
STORY19	C14	1.2DLLLEQY	1.25	-682.23	22.35	0.236	6.223
STORY20	C14	1.2DLLLEQY	1.25	-347.61	25.91	0.125	3.862

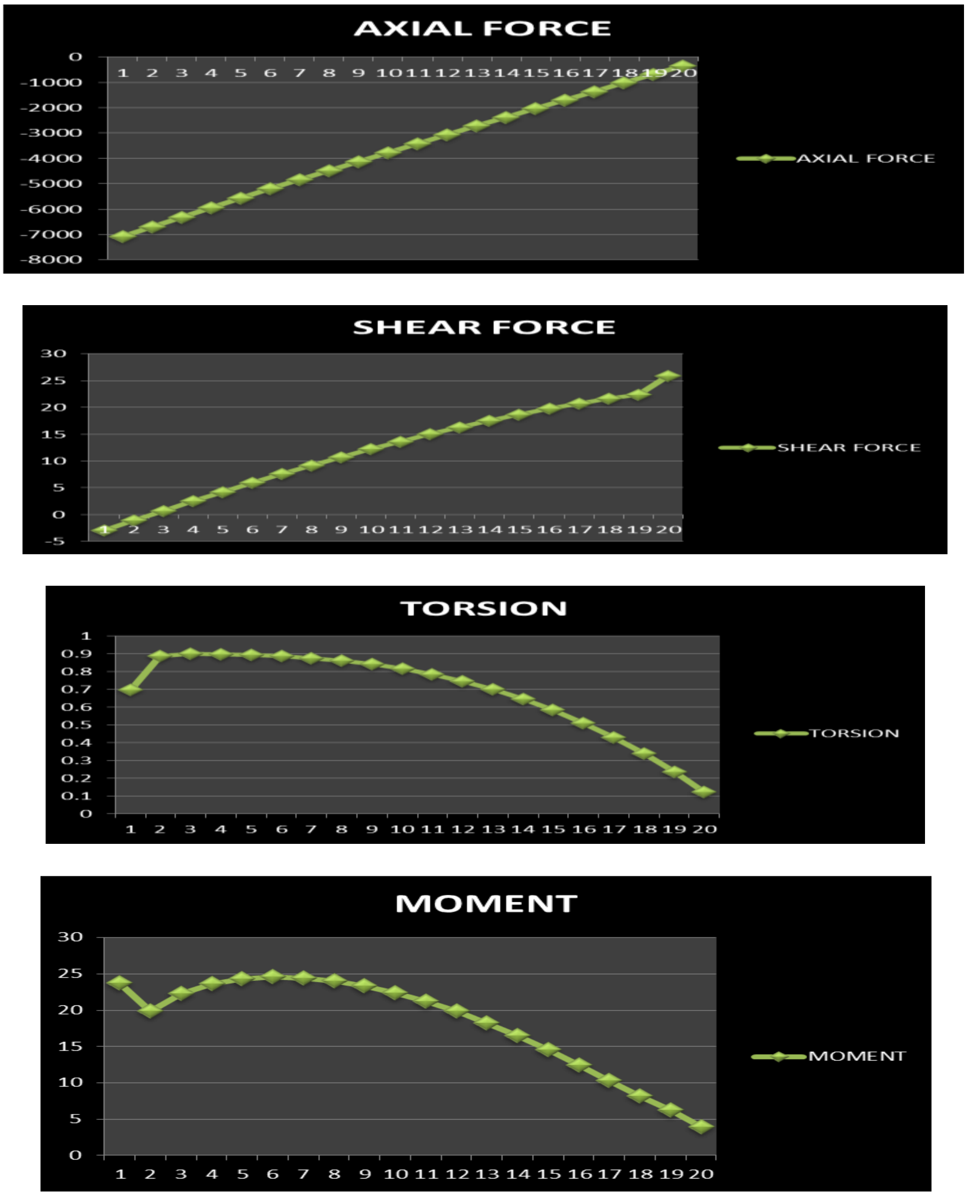
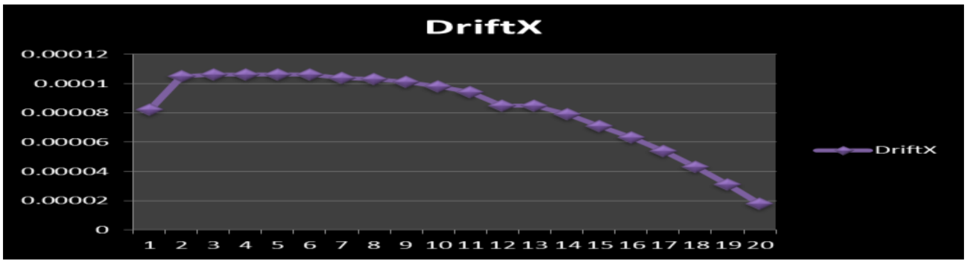


Figure 12: Axial force, Shear Force, Torsion and Moment for columnC14

Table X: Story Drift in X and Y Direction

Story	Load	DriftX	DriftY
STORY20	DLLLLEQY	0.000018	
STORY20	DLLLLEQY		0.000292
STORY19	DLLLLEQY	0.000031	
STORY19	DLLLLEQY		0.000355
STORY18	DLLLLEQY	0.000043	
STORY18	DLLLLEQY		0.000416
STORY17	DLLLLEQY	0.000054	
STORY17	DLLLLEQY		0.000476
STORY16	DLLLLEQY	0.000063	
STORY16	DLLLLEQY		0.000532
STORY15	DLLLLEQY	0.000071	
STORY15	DLLLLEQY		0.000584
STORY14	DLLLLEQY	0.000079	
STORY14	DLLLLEQY		0.00063
STORY13	DLLLLEQY	0.000085	
STORY13	DLLLLEQY		0.000669
STORY12	DLLLLEQY	0.000085	
STORY12	DLLLLEQY		0.000702
STORY11	DLLLLEQY	0.000094	
STORY11	DLLLLEQY		0.000728
STORY10	DLLLLEQY	0.000098	
STORY10	DLLLLEQY		0.000747
STORY9	DLLLLEQY	0.000101	
STORY9	DLLLLEQY		0.000759
STORY8	DLLLLEQY	0.000103	
STORY8	DLLLLEQY		0.000763
STORY7	DLLLLEQY	0.000104	
STORY7	DLLLLEQY		0.00076
STORY6	DLLLLEQY	0.000106	
STORY6	DLLLLEQY		0.000747
STORY5	DLLLLEQY	0.000106	
STORY5	DLLLLEQY		0.000723
STORY4	DLLLLEQY	0.000106	
STORY4	DLLLLEQY		0.000684
STORY3	DLLLLEQY	0.000106	
STORY3	DLLLLEQY		0.000626
STORY2	DLLLLEQY	0.000105	
STORY2	DLLLLEQY		0.000541
STORY1	DLLLLEQY	0.000082	
STORY1	DLLLLEQY		0.000371



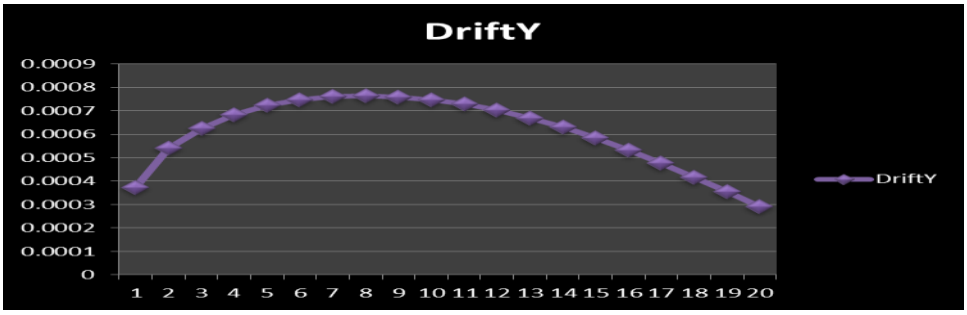


Figure13: Story Drift in X& Y Direction

II. DISCUSSION ON RESULTS

When a structure is subjected to earthquake, it responds by vibrating. An example force can be resolved into three mutually perpendicular directions- two horizontal directions (X and Y directions) and the vertical direction (Z). This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. All the structures are primarily designed for gravity loads-force equal to mass time's gravity in the vertical direction. Because of the inherent factor used in the design specifications, most structures tend to be adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans those in which stability for design, or for overall stability analysis of structures. The basic intent of design theory for earthquake resistant structures is that buildings should be able to resist minor earthquakes without damage, resist moderate earthquakes without structural damage but with some non-structural damage. To avoid collapse during a major earthquake, Members must be ductile enough to absorb and dissipate energy by post elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the event of the failure of key elements. When the primary element or system yields or fails, the lateral force can be redistributed to a secondary system to prevent progressive failure.

IS 1893 (part- 1) Code recommends that detailed dynamic analysis, or pseudo static analysis should be carries out depending on the importance of the problems.

IS 1893 (part- 1) Recommends use of model analysis using response spectrum method and equivalent lateral force method for building of height less than 40m in all seismic zones as safe., but practically there may be the building which are more than 40m in height. So there exist so many problems due to the increase in height of the structure.

The earthquake resistant structures are constructed using IS 1893 part-1 and there are some assumptions to be made in the design according to the codal provisions and these assumptions account to one of the uncertainties that occur in the design starting from mix design to workmanship and many other

The following assumptions shall be made in the earthquake resistant design of structures:

Earthquake causes impulsive ground motions, which are complex and irregular in character, changing in period and amplitude each lasting for a small duration. Therefore, resonance of the type as visualized under steady-state sinusoidal excitations will not occur as it would need time to buildup such amplitudes. The structural prototype is prepared and lots of data is been collected from the prototype. All the aspects such as safety of structure in shear, moment and in story drift have been collected. So now to check whether to know whether the structure is safe with established shear walls and all construction of core wall in the center we need to compare the graphical values of structure with the shear wall and a simple rigid frame structure.

Story Drift

The tallness of a structure is relative and cannot be defined in absolute terms either in relation to height or the number of stories. The council of Tall Buildings and Urban Habitat considers building having 9 or more stories as high-rise structures. But, from a structural engineer's point of view the tall structure or multi-storied building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. So lateral forces due to wind or seismic loading must be considered for tall building design along with gravity forces vertical loads. Tall and slender buildings are strongly wind sensitive and wind forces are applied to the exposed surfaces of the building, whereas seismic forces are inertial (body forces), which result from the distortion of the ground and the inertial resistance of the building. These forces cause horizontal deflection is the predicted movement of a structure under lateral loads and story drift is defined as the difference in lateral deflection between two adjacent stories. Lateral deflection and drift have three effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, nonstructural elements, and adjacent structures.

When the initial sizes of the frame members have been selected, an approximate check on the horizontal drift of the structures can be made. The drift in the non-slender rigid frame is mainly caused by racking. This racking may be considered as comprising two components: the first is due to rotation of the joints, as allowed by the double bending of the girders, while the second is caused by double bending of the columns. If the rigid frame is slender, a contribution to drift caused by the overall bending of the frame, resulting from axial deformations of the columns, may be significant. If the frame has height width ratio less than 4:1, the contribution of overall bending to the total drift at the top of the structure is usually less than 10% of that due to racking. [2]. The following method of calculation for drift allows the separate determination of the components attributable to beam bending, and overall cantilever action.

Drift problem as the horizontal displacement of all tall buildings is one of the most serious issues in tall building design, relating to the dynamic characteristics of the building during earthquakes and strong winds. Drift shall be caused by the accumulated deformations of each member, such as a beam, column and shear wall. In this study analysis is done with changing structural parameters to observe the effect on the drift (lateral deflection) of the tall building due to both wind and earthquake loading. There are three major types of structures were identified in this study, such as rigid frame, coupled shear wall and wall frame structures.

Is 1893 Part 1 CodalProvoisions for Storey Drift Limitations

The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1.0, shall not exceed 0.004 times the storey height For the purposes of displacement requirements only, it is permissible to use seismic force obtained from the computed fundamental period (T) of the building without the lower bound limit on design seismic force specified in dynamic analysis.The tallness of a structure is relative and cannot be defined in absolute terms either in relation to height or the number of stories. The council of Tall Buildings and Urban Habitat considers building having 9 or more stories as high-rise structures. But, from a structural engineer's point of view the tall structure or multi-storied building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. So lateral forces due to wind or seismic loading must be considered for tall building design along with gravity forces vertical loads. Tall and slender buildings are strongly wind sensitive and wind forces are applied to the exposed surfaces of the building, whereas seismic forces are inertial (body forces), which result from the distortion of the ground and the inertial resistance of the building. These forces cause horizontal deflection is the predicted movement of a structure under lateral loads . Lateral deflection and drift have three effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, nonstructural elements, and adjacent structures. When the initial sizes of the frame members have been selected, an approximate check on the horizontal drift of the structures can be made. In this study analysis is done with changing structural parameters to observe the effect on the lateral deflection of the tall building due to earthquake loading. There are three major types of structures were identified in this study, such as rigid frame, coupled shear wall and wall frame structures.

III. CONCLUSION

I. It is evident from the observing result that the shear wall are making value of torsion very low.
II. It is evident from the observing result that for combination loads 1.2 DLLLEQX&1.2DLLLEQY ,maximum value of moment at story one and minimum value of shear force also at story one . The Moment is maximum when the shear force is minimum or changes sign.
III. The story drift for the combination loadDL+LL+EQy in X&Y direction shown different performance and less value for story drift in all combinations at story 20.The value of story drift is very low because of adding shear walls to the building
IV. Based on the analysis and discussion ,shear wall are very much suitable for resisting earthquake induced lateral forces in multistoried structural systems when compared to multistoried structural systems whit out shear walls. They can be made to behave in a ductile manner by adopting proper detailing techniques.
V. Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces.
VI. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them, such as other shear walls, floors, foundation walls, slabs or footings.
IV. For the columns located away from the shear wall the Bending Moment is high and shear force is less when compared with the columns connected to the shear wall.
VIII. Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway.
IX. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports.
X. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage.
XI. The vertical reinforcement that is uniformly distributed in the shear wall shall not be less than the horizontal reinforcement .This provision is particularly for squat walls (i.e. Height-to-width ratio is about 1.0).However ,for walls whit height-to-width ratio less than 1.0, a major part of the shear force is resisted by the vertical reinforcement. Hence ,adequate vertical reinforcement should be provided for such walls.

VI. REFRENCES

[1] *IS-456-2000-Code of Practice for Plane and Reinforced Concrete .*

[2] *IS 1893(Part 1)-2002:Eriteria for Earthquake Resistant Design of Structure .*

[3] *IS:875(Part1)-1987- Code of Practice for Design Load(other than earthquake) for Buildings andStructure –Dead loads*

[4] *IS:875(Part2)-1987- Code of Practice for Design Load(other than earthquake) for Buildings andStructure –Imposed Load*

[5] *IS:875(Part2)-1987- Code of Practice for Design Load(other than earthquake) for Buildings andStructure –Wind Load*

[6] *Mark fintel-Hand Book of Concrete Engineering. Second Edition .CBS Publishers &Distributors-New Delhi,2004*

[7] *Anil k.Chopra-Dynamics of Structure :Theory and Application to Earthquake Engineering, SecondEdition ,Pearson Education (Singapore) Pvt.Ltd 2005*

[8] *Mariopaz-Structure Dynamics : Theory and Computations,(Second Edition) , .CBS Publishers&Distributors-New Delhi,2004*

[9] *Indian Society of Earthquake Technology –Proceedings of the Sixth World Conference EarthquakeEngineering,Vol.1,Published by Sarita Prakashan,Merut,1977.*

[10] *A.r.chandrasekharan and D.s.prakashrao –a Seismic Design of Multi –Storied RCC Buildings (published in the proceeding ot the 12th symposium on earthquake engineering held iit-roorkee in dec 2002)*

[11] *Medhekar,m.s,andJain,s,k, Seismic Behavior ,Design and Detailing of RC Shear Wall,part 1:behavior and strength –an icj compilation .*

[12]. *Kaustubhdasgupta ,C.v.r.murty and Shaileshk.agrawal,Seismic Shear Design of RC Structural Walls897-971.*

[13] *Crandell, J., and S. Herrenbruck. 2006.Residential wall bracing principles and design options. Journal of Building Safety. August2006*

[14] *Mahdi hosseini , Ahmed najim Abdullah alaskari,Prof.N.V.RamanaRao, International Journal of Civil Engineering and Technology (IJCIET), ISSN 0976 –6316(Online), Volume 5, Issue 8, August (2014)*

[15] *Dr,hadihosseini, Mahdi hosseini, ahmadhosseini,American journals of engineering and research e-ISSN : 2320-0847 p-ISSN : 2320-0936, Volume-03, Issue-10 november2014*

[16] *Dr,hadihosseini,Mahdi hosseini, ahmadhosseini,American journals of engineering and research e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-03, Issue-11,october 2014*

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